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THE EFFECTS ON HUMAN HEALTH FROM LONG-TERM EXPOSURES TO NOISE.(U)
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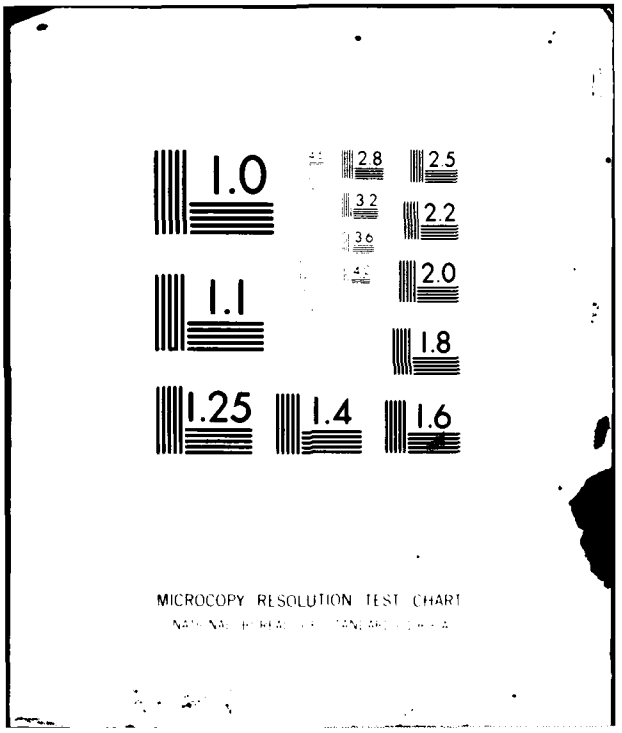
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(1) LEVEL II

THE EFFECTS ON HUMAN HEALTH FROM LONG-TERM EXPOSURES TO NOISE

Report of Working Group 81

Committee on Hearing, Bioacoustics, and Biomechanics
Assembly of Behavioral and Social Sciences
National Research Council

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1981

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This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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SCOPE OF THE PROBLEM

The Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) was asked by the National Institute for Occupational Safety and Health (NIOSH) to consider research that might be performed to examine the effects on human health from long-term exposure to noise. Hearing loss and speech interference, as auditory problems connected with excessive noise, were considered by NIOSH to be well documented and were not the subject of this request, nor were the effects of acoustical energy in the non-audible range such as infrasound and ultrasound. Consideration of possible effects of noise on the fetus of pregnant women working in industry was also excluded since this is the subject of a separate working group of CHABA. The Environmental Protection Agency (EPA) asked that CHABA consider not only the industrial population but also the general population.

In response to the request of NIOSH and EPA, CHABA established Working Group 81, which reviewed studies concerning the effects of noise upon human health with the exclusions noted above.* Because of NIOSH concerns, particular emphasis was placed upon exposure to noise at levels of 90 dBA or more for periods of eight hours per day, five days per week, over at least ten years.

It is estimated that in industry alone between two and ten million workers are exposed to continuous noise levels of approximately 90 dBA or more during their workday. Data are not available for the number of those exposed in nonindustrial occupations to similar noise levels, those who in their recreational and avocational lives are exposed to such levels over an extended number of years, and those who have left industry after employment of ten years or more.

Present standards permit levels up to 90 dBA for an unprotected ear for an eight-hour workday. Working Group 81 was aked whether those noise standards established to safeguard hearing are sufficient also to protect aginst health disorders other than hearing deficits.

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* The studies reviewed are representative of the literature but do not comprise a complete review.

Evidence from available research reports is suggestive, but it does not provide definitive answers to the question of health effects, other than to the auditory system, of long-term exposure to noise. It seems prudent, therefore, in the absence of adequate knowledge as to whether or not noise can produce effects upon health other than damage to the auditory system, either directly or mediated through stress, that insofar as feasible, an attempt should be made to obtain more critical evidence. For this reason, guidance is provided as to the kinds of studies that would be helpful in answering this question for NIOSH and EPA.

PAST RESEARCH

A number of cross-sectional studies from Europe--recently primarily from Eastern European countries--have reported a greater prevalence of hypertension [1-5,15] and other cardiovascular changes [6,7] among workers exposed to high noise levels for long periods than among other groups of workers exposed to lower noise levels. Some additional studies, [8-10] although not all of those available, [11] suggest an association between severe noise-induced hearing impairment and increased prevalence of hypertension. Still other investigations, also reported in the foreign literature, link excessive noise exposure in industry with increased incidence of neurologic and gastrointestinal disturbances. Many of the available foreign studies can be criticized on methodological grounds. For example, studies indicating relationships between noise and cardiovascular problems were not adequately controlled for other known risk factors, such as those related to smoking, body weight, diet, and heredity. Studies in the United State have been more limited, both in scope and in numbers. The studies in the United States primarily concentrated on cardiovascular response to noise, and the results have been contradictory.[12-14] However, positive findings that can be gleaned from many of the reports cited above (see also 16) suggest the possibility that long-term exposure to noise is a risk factor that deserves further consideration.

RECOMMENDATIONS

If there are nonauditory health effects, they are most likely the result of a combination of environmental "stressors" (factors that may cause stress), including noise. As noted above, some evidence indicates that stress effects may be manifested most prominently as changes in blood pressure regulation and other anomalies, ranging from psychosomatic complaints to gastrointestinal ulcers. However, since cardiovascular effects are known to result from stress and since they are relatively easy to assess experimentally, measure of cardiovascular function and structure should be among the first kinds of reactions examined in any future work aimed at clarifying the significance of the nonauditory effects of long-term exposures to noise. Moreover, noise acting as a stressor might alter the organism's capacity to withstand insults from other physical agents or environmental contaminants. Appropriate studies for analyzing a combination of exposure conditions for possible interactive effects are in order.

Because noises are often associated with operations that are hazardous for other reasons, the message of hazard carried by noise, and not the direct effect of the noise, may produce or enhance the stress of the situation. Stressors of this kind may be difficult to identify and their effects difficult to separate from more direct effects of noise. They should be kept in mind in the planning and conduct of future studies.

Additional research will be necessary in order to obtain critical evidence as to whether detrimental health effects, other than those to the auditory system, do or do not occur as the result of long-term exposure to high-level noise. Additional research will also be necessary to determine whether noise standards established for safeguarding hearing are also adequate to minimize any nonauditory health effects from such exposures. The appropriate studies will be difficult and expensive both in cost and in commitment of time by research personnel for data acquisition and analysis. To demonstrate that long-term exposure to high-level noise per se is a risk factor for cardiovascular or other disorders, it is necessary that highly sophisticated epidemiological studies be conducted with controls for other known risk factors. Other risk factors that should be considered are: age, sex, smoking, caffeine, body weight, diet, and hereditary proclivity; factors

related to stress associated with physical hazards in job performance and work output requirement; factors in the work environment that might be associated with noise, such as heat, dust, toxic fumes, and vibration; and factors in nonwork living environment of the workers. Less careful and complete research will only produce results that are as ambigious as those now available. If new studies are proposed, we recommend that the designs be reviewed by an appropriately qualified group of experts.

Although interspecies comparisons must always be made with extreme caution, it is widely acknowledged that, under some circumstances, the study of animal models can provide valuable, adjunctive information regarding human reactions to noise. Earlier research in which different nonauditory effects of noise were explored in nonhuman species produced, in the main, positive results, but the procedures and controls used have subsequently been criticized on a number of grounds. Furthermore, it is difficult to evaluate the results of such experiments because of the great variability in the response of experimental animals to high-level noise.

Most animals show unlearned aversive responses to loud sounds, often to frequencies outside the range of human hearing, but the kind and degree of response differ widely among species. For example, audiogenic seizures can be produced in some rodents. Unlearned aversive responses to loud sounds are undoubtedly present in humans as well as in animals but, because of habituation, may not be readily observable. It is possible in animal experiments to superimpose learned aversive responses to noise upon those that are already innately present. Thus, animals models might provide an excellent test to distinguish between the basic biological effect of loud noise and the overlay of learned fear or stress. The latter can then be induced in animals by fear conditioning procedures. One might then be able to distinguish between the learned and unlearned aspects of loud noise stress.

If one can find an appropriate animal model, then with careful controls and the development of refined techniques of training animals in high-level noise environments, and measuring cardiovascular, endocrinological, central nervous system, behavioral, and other reactions, valuable data may be obtained from the experimental laboratory. In addition, the following suggestions are made as examples of procedures to be considered in future animal experiments:

1. The species selected should resemble humans (as closely as feasible) with regard to the system under study and its control substrate.
2. The stimulus should be monitored often, specified in accordance with modern standards, and should be matched to the hearing capacities of the subject species.
3. Confounding variables that might interact with, or mimic the effects, of noise should be excluded, reduced, or held constant.
4. Measures of the responses of choice should be valid, unbiased, reliable, and made as frequently as possible.

5. Since chronic effects are of interest, the time frame of the experiment should occupy a significant portion of the life span of the subject species.

While this list is not all-inclusive, adherence to its tenets should enhance the contribution animal-model research can make toward our understanding of the ways in which noise may affect humans. [17]

In spite of the appealing prospects of using nonhuman subjects to discover relations between exposure to noise and health disorders, some members of CHABA wish to emphasize the difficulties of discovering appropriate animal models and the potential dangers of applying to man the findings of experiments using inappropriate animal models.

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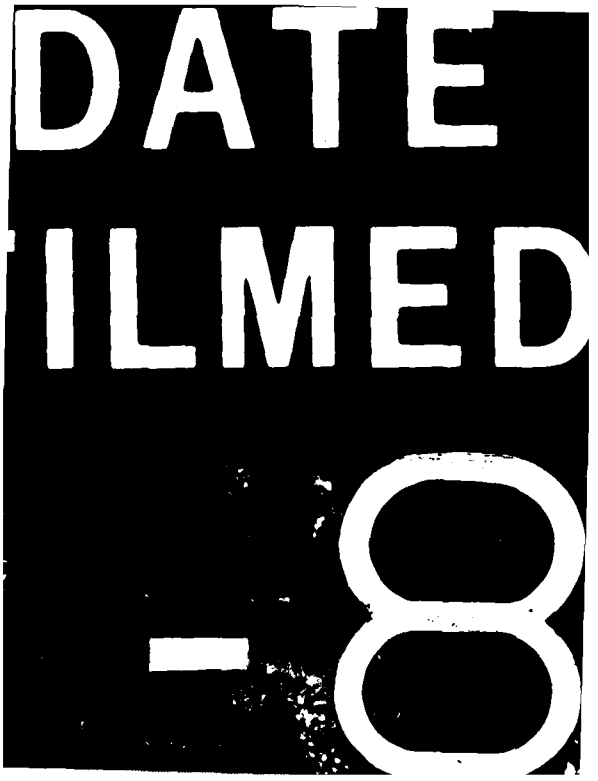
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